**Teacher Resource Pack**

**Unit Planning Resources**

**Subject Area/Grade:** Physical Science, grade 5 **Title:** Heat Energy **Estimated Time Frame:** \_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Unit Theme:**  **Conceptual Lens:**  Energy  Transformative processes  **Identify the Big Ideas:**  *(Align to Essential Standards)*  Heat energy  Heat transfer and transformation  Temperature | **GRAPHIC ORGANIZERS:**  NC Science Essential Standards; Physical Science Domain; Energy: Conservation and Transfer Strand  Atlas of Science Literacy Volume 2 page 25  Conduction, Convection and Radiation <http://www.biocab.org/Heat_Transfer.html>  Tree chart Heat transfer <http://books.google.com/books?id=4ZlvYPcCXSIC&pg=PA14&lpg=PA14&dq=graphic+organizer+convection+conduction+radiation&source=bl&ots=fKwrtdp9nd&sig=z8uuIo0be4vO5ayfJAgG1_eJ5QQ&hl=en&ei=RXBSTo-uEY3E0AHdm8DlBg&sa=X&oi=book_result&ct=result&resnum=2&ved=0CB4Q6AEwATge#v=onepage&q=graphic%20organizer%20convection%20conduction%20radiation&f=false>  CPO Heat Transfer Venn diagram <http://www.cpo.com/home/ForEducators/MiddleSchoolEarthScience/tabid/261/Default.aspx>  Qwiki graphic organizers:  Temperature <http://www.qwiki.com/q/#!/Temperature>  Heat <http://www.qwiki.com/q/#!%2FHeat> | | | |
| **Enduring Understandings**  *(Generalizations)*  Heat energy is a property of many substances and many processes give off heat energy.  Heat energy moves in predictable ways.  When two objects are rubbed against each other, they both get warmer. In addition, many mechanical and electrical devices get warmer when they are used.  When warmer things are put with cooler ones, the warmer things get cooler and the cooler things get warmer until they all are the same temperature.  When warmer things are put with cooler ones, heat is transferred from the warmer ones to the cooler ones.  A warmer object can warm a cooler one by contact or at a distance. | **NC Science Essential Standards**  **5.P.3 Explain how the properties of some materials change as a result of heating and cooling.**  5.P.3.1 Explain the effects of the transfer of heat (either by direct contact or at a distance) that occurs between objects at different temperatures. (conduction, convection or radiation).  5.P.3.2 Explain how heating and cooling affect some materials and how this relates to their purpose and practical applications. | **Essential Questions**  *(Guiding Questions)*  What is heat? How can heat change the properties of a substance? Does heat energy behave in predictable ways? How does heat move from one place to another? How do we explain conduction? How do we explain convection? How do we explain radiation? What are some natural examples of each type of heat transfer?  What is temperature? | | |
| **Essential Terminology**  conduction  convection  radiation  temperature | | | |
| **Identify Misconceptions**  \*Construct formative assessment probes – see ‘how to’ on pages 85, 102, and 183 in Science Formative Assessment by Page Keeley.  Use formative probes: Uncovering Student ideas in Science, Volumes 1-4, by Page Keeley  (I) Volume 1 The Mitten Problem p. 103 (II) Volume 1 Objects and temperature p. 109 (III) Volume 2 Turning the Dial p. 47 (IV) Volume 2 Boiling Time and Temperature p. 53 (V) Volume 2 Freezing Ice p. 59 (VI) Volume 2 Ice Cold lemonade p. 78 (VII) Volume 2 Mixing water p. 83 (VIII) Volume 3 Where did the water come from? P. 163 (IX) Volume 4 Iron Bar p. 17 (X) Volume 4 Ice Water p. 45 (XI) Volume 4 Warming Water p. 53  Formative Assessment Probes (articles, how-to, free-online) by Page Keeley, et al <http://pal.lternet.edu/docs/outreach/educators/education_pedagogy_research/assessment_probes_uncovering_student_ideas.pdf>  <http://www.ode.state.or.us/teachlearn/subjects/science/resources/msef2010-formative_assessment_probes.pdf> | | | | |
| **Unpacked Content** | **Science For All Americans** | | **Benchmarks Reference** | |
| 5.P.3.1  Students know that when warmer things are put with cooler things, the warmer things lose heat and the cool things gain it until they are all at the same temperature. Students know that a warmer object can warm a cooler object by contact or at a distance. Conduction is the transfer of thermal energy between things that are touching. Conduction can happen within one object. (For example, thermal energy can be conducted through the handle of a metal pot.) Convection is the movement of thermal energy by the movement of liquids or gases. Convection in the oceans and atmosphere helps to move thermal energy around Earth, and is an important factor influencing weather and climate. Radiation is the transfer of energy by electromagnetic waves. Electromagnetic waves can carry energy through places with or without any matter. The Sun is the main source of electromagnetic energy on Earth. Part of this energy, light, is used by producers to make food. Radiation can also happen in other circumstances (i.e. sitting in front of a fireplace).  5.P.3.2  Students know that heating and cooling can cause changes in the properties of materials, but not all materials respond the same way to being heated and cooled. Students know that heating and cooling cause changes in the properties of materials, such as water turning into steam by boiling and water turning into ice by freezing. Students know and notice that many kinds of changes occur faster at higher temperatures. Students know that some materials conduct heat much better than others, and poor conductors can reduce heat loss. | ENERGY TRANSFORMATIONS Energy appears in many forms, including radiation, the motion of bodies, excited states of atoms, and strain within and between molecules. All of these forms are in an important sense equivalent, in that one form can change into another. Most of what goes on in the universe—such as the collapsing and exploding of stars, biological growth and decay, the operation of machines and computers—involves one form of energy being transformed into another.  Forms of energy can be described in different ways: Sound energy is chiefly the regular back-and-forth motion of molecules; heat energy is the random motion of molecules; gravitational energy lies in the separation of mutually attracting masses; the energy stored in mechanical strains involves the separation of mutually attracting electric charges. Although the various forms appear very different, each can be measured in a way that makes it possible to keep track of how much of one form is converted into another. Whenever the amount of energy in one place or form diminishes, the amount in another place or form increases by an equivalent amount. Thus, if no energy leaks in or out across the boundaries of a system, the total energy of all the different forms in the system will not change, no matter what kinds of gradual or violent changes actually occur within the system.  But energy does tend to leak across boundaries. In particular, transformations of energy usually result in producing some energy in the form of heat, which leaks away by radiation or conduction (such as from engines, electrical wires, hot-water tanks, our bodies, and stereo systems). Further, when heat is conducted or radiated into a fluid, currents are set up that usually enhance the transfer of heat. Although materials that conduct or radiate heat very poorly can be used to reduce heat loss, it can never be prevented completely.  Therefore the total amount of energy available for transformation is almost always decreasing. For example, almost all of the energy stored in the molecules of gasoline used during an automobile trip goes, by way of friction and exhaust, into producing a slightly warmer car, road, and air. But even if such diffused energy is prevented from leaking away, it tends to distribute itself evenly and thus may no longer be useful to us. This is because energy can accomplish transformations only when it is concentrated more in some places than in others (such as in falling water, in high-energy molecules in fuels and food, in unstable nuclei, and in radiation from the intensely hot sun). When energy is transformed into heat energy that diffuses all over, further transformations are less likely.  The reason that heat tends always to diffuse from warmer places to cooler places is a matter of probability. Heat energy in a material consists of the disordered motions of its perpetually colliding atoms or molecules. As very large numbers of atoms or molecules in one region of a material repeatedly and randomly collide with those of a neighboring region, there are far more ways in which their energy of random motion can end up shared about equally throughout both regions than there are ways in which it can end up more concentrated in one region. The disordered sharing of heat energy all over is therefore far more likely to occur than any more orderly concentration of heat energy in any one place. More generally, in any interactions of atoms or molecules, the statistical odds are that they will end up in more disorder than they began with.  It is, however, entirely possible for some systems to increase in orderliness—as long as systems connected to them increase even more in disorderliness. The cells of a human organism, for example, are always busy increasing order, as in building complex molecules and body structures. But this occurs at the cost of increasing the disorder around us even more—as in breaking down the molecular structure of food we eat and in warming up our surroundings. The point is that the total amount of disorder always tends to increase. | | 4E | |
| **North Carolina Connections:** (local and state resources)  [**Catawba Science Center**](http://www.catawbascience.org/) CSC also provides a variety of educational and fun programming for school groups, children, families, adults, and other community groups. 243 3rd Avenue NE (street address), P.O. Box 2431, Hickory, NC 28603, (828) 322-8169  [**Imagination Station Science Museum**](http://www.imaginescience.org/) Interactive programs are designed to promote student investigation into various science concepts. 224 East Nash Street,Wilson, NC 27894 Phone (252) 291-5113.  [**North Carolina Museum of Life and Science**](http://www.ncmls.org/) Experience how inquiry-based teaching energizes your students and encourages science discovery. 433 West Murray Avenue (street address), P.O. Box 15190, Durham, NC 27704, (919) 220-5429  [**SciWorks, the Science Center and Environmental Park of Forsyth County**](http://www.sciworks.org/) Enjoy interactive, hands-on special exhibits and programs in spacious exhibit halls. 400 West Hanes Mill Rd., Winston-Salem, (336) 767-6730  **North Carolina NASA Educator Resource Center** J. Murrey Atkins Library UNC Charlotte 9201 University City Blvd., Charlotte, NC 28223 704-687-2559 | | | | |
| **Annotated TEACHER Resources**  [**SciGirls Doghouse Design**](http://pbskids.org/dragonflytv/pdf/DoghouseDesign.pdf)  <http://pbskids.org/dragonflytv/pdf/DoghouseDesign.pdf>  This activity (on page 2 of the PDF) is a full inquiry investigation into absorption and reflection of radiant energy. In order to build a house that keeps a dog as cool possible in the heat, learners set up an experiment to find out if paint color affects temperature.  [**Atmospheric Processes--Radiation**](http://www.ucar.edu/learn/1_1_2_5t.htm)  <http://www.ucar.edu/learn/1_1_2_5t.htm>  This activity begins with an explanation of the heat transfer processes in general and then focuses on radiation. In the activity, students investigate how different surfaces absorb heat and apply their experience with the surfaces to interpret real-world situations.  [**Atmospheric Processes-Conduction**](http://www.ucar.edu/learn/1_1_2_6t.htm)  <http://www.ucar.edu/learn/1_1_2_6t.htm>  This activity begins with an explanation of the heat transfer process of conduction, the process by which heat energy is transmitted through collisions between neighboring molecules. In the activity, students are asked to explain the process of conduction using a molecular model and explain that different materials conduct at different rates.  [**Build a Solar Oven**](http://www.compadre.org/precollege/items/detail.cfm?ID=6014)  <http://www.re-energy.ca/solar-oven>  This website has lesson plans to build energy projects such as this solar oven. Teacher support and information is also available.  [**The Sun Times: The Global Sun Temperature Project**](http://www.compadre.org/precollege/items/Load.cfm?ID=8173)  <http://www.ciese.org/curriculum/tempproj/en/index.shtml>  This is the home page of a global project developed to involve K-12 students in a study of global climate and temperature.  Participation is free with registration.  Students measure daily temperature, record the number of minutes of sunlight per day, and submit their data online.  The web site contains tools for data comparison and storage.  Students graph and analyze results, and then share conclusions about causes of global temperature variation in a final report submitted to the website.  Included are detailed project instructions, a teacher guide, reference material, and a student discussion forum.  [**Cycles of the Earth and Atmosphere: Introduction to the Atmosphere**](http://www.compadre.org/precollege/items/Load.cfm?ID=8182)  <http://www.ucar.edu/learn/1_1_1.htm>  This web page is a module for Grades 5-8 on the topic of Earth's atmosphere.  It contains background information for teachers on atmospheric gases and their properties, explains how energy is transferred between the earth's surface and the atmosphere, and discusses the role ocean currents play in transferring heat.  Included are links to seven classroom activities and labs on radiation, conduction, convection, the water cycle, and more.  **Atmospheric Processes: Radiation**  <http://www.ucar.edu/learn/1_1_2_5t.htm>  This web page is a teacher's guide for an activity on heat transfer through radiation.  Students investigate the relative absorption of light energy by water, light soil, and dark soil.  Included is background information for teachers, labs with printable student guides, extension activities, and ideas for assessment.  Each module is aligned to both NSES standards and AAAS Benchmarks.  **Teachers Domain HEAT TRANSFER**  <http://www.teachersdomain.org/resource/lsps07.sci.phys.energy.heattransfer/>  This item is an interactive Flash animation for Grades 5-8 on the topic of heat.  Users explore methods of heat transfer and classify examples from everyday life.  Three methods of heat transfer are depicted: conduction, convection, and radiation.  [**Teach Engineering: How Hot Is It?**](http://www.compadre.org/precollege/items/detail.cfm?ID=8202)  <http://www.teachengineering.org/view_lesson.php?url=http://www.teachengineering.org/collection/cub_/lessons/cub_energy2/cub_energy2_lesson06.xml>  In this 3-day module for Grades 3-5, kids have fun learning about thermometers, temperature conversions, conduction, radiation, convection, and heat capacity.  Well-organized resource includes a teacher-led introduction, a hands-on class activity, and an inquiry-based lab.  [**Teach Engineering: Make Your Own Temperature Scale**](http://www.compadre.org/precollege/items/Load.cfm?ID=8201)  <http://www.teachengineering.org/view_activity.php?url=http://www.teachengineering.com/collection/cub_/activities/cub_energy2/cub_energy2_lesson06_activity1.xml>  In this 50-minute activity for grades 3-5, students construct a simple thermometer using 2-liter bottles, straws, and an alcohol-water mixture.  The primary objective is to help young students understand the difference between temperature and thermal energy.  **How Much Heat Will It Hold?**  <http://www.teachengineering.org/view_activity.php?url=http://www.teachengineering.org/collection/cub_/activities/cub_energy2/cub_energy2_lesson06_activity2.xml>  This is a 50-minute lab for grades 3-5 on the topic of heat capacity.  Students work in teams to collect data on the heat capacity of various common materials.  The main objective is to promote understanding of how heat capacity is related to the storage of thermal energy.  **NEOK12 Heat and Temperature**  <http://www.neok12.com/Heat-Temperature.htm>  A collection of videos, lessons and games.  **Energy: Heat: Conduction, Convection, and Radiation**  <http://ethemes.missouri.edu/themes/1369>  Explore these sites to learn about heat transfer and thermal insulators. Find out how molecules movement in all types of matter generates heat. Learn about conduction, convection, and radiation.  **\*NASA Resource: Hurricanes as Heat Engines**  <http://mynasadata.larc.nasa.gov/preview_lesson.php?&passid=50>  Students examine authentic sea surface temperature data to investigate how hurricanes extract heat energy from the ocean surface.  **Smart Exchange**  <http://exchange.smarttech.com/search.html>  A directory of Smart Board lessons that teachers can download and use.  **Teachers Domain**  <http://www.teachersdomain.org/>  Free digital media for educational use.  **Bill Nye**  <http://www.teachertube.com/viewVideo.php?video_id=186099>  Heat video 1 What heat is  <http://www.teachertube.com/viewVideo.php?video_id=186395&title=Bill_Nye_heat_2>  Heat video 2 transfer of heat  <http://www.videosurf.com/video/bill-nye-the-science-guy-on-heat-full-clip-86007993>  Heat video full clip  **HEAT Rap Video**  <http://www.teachertube.com/viewVideo.php?video_id=159713> | | | | |
| **WRITING PROMPTS**   1. Write an essay describing what happens to the heat energy from a gas stove when you boil an egg in a pot of water. 2. It is freezing outside! Describe how you will dress in order to stay warm as you hike to the park a half mile away. 3. You have just made yourself a nice hot cup of tea. You are blowing on the top of the tea so you will not burn your mouth. Write an essay explaining why the blowing will cool off the tea so that it is safe to drink. 4. There is a need to conserve energy; if we are to make our natural resources last as long as possible. Some people do this by lowering their thermostat in the winter months, and their homes feel a little cool inside. Often, they have to wear sweaters indoors to stay warm. Do you think people should be required to conserve heat energy this way? Explain your position. 5. In North Carolina, we experience four seasons. This doesn’t happen everywhere on earth. Some places stay hot year round, while others stay cold year round. If you had to relocate to such a place, and you had to choose between them, which would you choose – hot or cold? Explain the reasons for your choice. | | | | |